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Committee on the Assessment of Human Health Effects of Great Lakes Water Quality. Report: 1987

Committee on the Assessment of Human Health Effects of Great Lakes Water Quality

Great Lakes Water Quality Board/Science Advisory Board

Report to the International Joint Commission

1987 Report of the Committee on the Assessment of Human Health Effects of Great Lakes Water Quality

D4608S (Revised Final Draft November 9/87)

PREFACE

The 1987 Annual Report of the International Joint Commission's Committee on the Assessment of Human Health Effects of Great Lakes Water Quality was prepared for both the Water Quality Board and for the Science Advisory Board.

The report includes highlights of activities undertaken by the Committee between its last report in October 1986 and the present.

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INTRODUCTION

The Committee on the Assessment of Human Health Effects of Great Lakes Water Quality is pleased to provide the Water Quality Board and the Science Advisory Board with this report that describes its progress over the last twelve months. It provides background information on two major projects that are nearing completion: the usefulness of epidemiology for evaluating the impact of environmental contaminants on health; and the potential health hazards posed by approximately 130 chemicals found in the Great Lakes ecosystem. This report contains a proposal for work to be carried out on the basis for numerical limits for environmental contaminants set by Great Lakes jurisdictions and a proposal for the development of four emerging topics in toxicology evaluation that the Committee believes to be of significance to the Commission. In its last report, the Committee commented on the significance of alkylated lead in fish; this topic and information on another organo metal, alkylated tin, are also considered in this report.

1.0 EPIDEMIOLOGIC EVALUATION OF HUMAN HEALTH EFFECTS OF CHEMICALS IN THE GREAT LAKES

1.1 Background

There is widespread and legitimate concern that pollution of the Great Lakes may pose health risks for human populations using or consuming the water or fish. A comprehensive approach to establishing such cause (pollution) and effect (health risk) would include both epidemiological and toxicological studies. Until now, the evaluation of risks due to environmental pollution has been derived mainly from toxicological evidence in non-human species under experimental conditions with subsequent extrapolation to humans. By contrast, epidemiologic studies attempt to establish direct links between human health effects and their causes.

For these reasons it is understandable that there is increasing public pressure to carry out epidemiologic investigations to determine if some community is experiencing increased risk due to some particular case of environmental pollution. Often these pressures lead to hasty comparisons of the mortality and morbidity rates in the index population with those in some other population. Conclusions from such comparisons are often scientifically worthless and because of the publicity they receive and the stress they cause, may even be harmful. Properly conducted epidemiologic investigations and their interpretation usually require considerable expertise and effort. The easy availability of rudimentary data is seductive but should not be substituted for proper investigations. Further, agencies must be prepared to accept that even well-designed studies may produce equivocal answers. Epidemiological studies are methodologically difficult and expensive to conduct, however, these difficulties may not be insurmountable.

The International Joint Commission is interested in defining the role to be played by epidemiology in the assessment of impact of environmental contaminants in the Great Lakes basin. In addition, the Great Lakes Toxic Substances Agreement, recently signed by the Governors of the eight states bordering the Great Lakes, provides a mandate for coordination of state health outcome databases and development of regionally compatible approaches to using these data sources.

The Committee is therefore seeking expert opinion on the feasibility of deriving epidemiologic conclusions in studies relating water quality and human health. A two-stage consultative process has been adopted. The first stage consists of the solicitation of position papers on a number of relevant topics by several recognized experts in epidemiology. These topics fall into two classes, empiric and speculative. The former concerns data sources and essentially requires the contractor to carry out a census and evaluation of data sources that might be of use to epidemiologists studying health effects in the Great Lakes basin. The latter addresses the potential benefits of various epidemiologic strategies for assessing or monitoring health effects possibly related to contaminants in Great Lakes water and fish. These strategies have been set forth in a series of papers commissioned by the Committee and which are currently under review.

The commissioned papers will form the background for the second stage, a workshop on epidemiologic strategies best suited for the Great Lakes basin. The workshop, planned for March 1988, will include the epidemiologists who prepared the background papers and experts active in this field to debate the best use of epidemiologic approaches for addressing questions concerning the human population in the Great Lakes basin.

The workshop and resulting report will address the usefulness of epidemiologic approaches and provide guidance on the feasibility of assessing impact on health of exposure to pollutants in the Great Lakes using such methodology. It is a logical continuation of the Committee's activities in epidemiology, i.e. response to public perceptions and the need for studies (1980); Workshop on the Compatibility of Cancer Registries (1981); the Roundtable on Surveillance and Monitoring (1982); and articles on methodologies and study designs on environmental epidemiology (1983; 1985). Definition of the role of epidemiology will lead to improved communication and feedback between the environmental monitoring and the epidemiologic activities under the Water Quality Agreement.

1.2 Recommendation

The Committee recommends that:

- *a workshop be held to debate the choice of epidemiologic strategies for investigating environmental health impacts and that the proceedings be published in order to provide guidance to agencies responsible for human health evaluation.*

2.0 NUMERICAL LIMITS FOR GREAT LAKES CONTAMINANTS: THE BASIS FOR AND VARIATIONS IN JURISDICTIONAL LIMITS USED IN THE GREAT LAKES BASIN

2.1 Background

The Committee has addressed various aspects of the generic issue of numerical limits, i.e. guidelines, objectives, standards, regulations, action levels, etc., since its formation in 1978. It has been noted that, given the methodologies used by the different jurisdictions and the risk management considerations, different limits might be developed for the same compound.

In 1983, the Committee addressed questions of public perception of environmental health issues. Reasons for differences in intervention levels between various jurisdictions were delineated and the relative roles of toxicology, epidemiology, technology and control strategy in setting these intervention levels were explained. The Committee indicated that there was a need to provide more information to the public on this process and that it should come from regulators. It addressed the evaluation process again in its 1985 report. While more detail is provided in past Committee reports, we believe it is worthwhile to again briefly describe the evaluation processes that lead to the development of numerical limits.

2.2 Current Approaches to the Derivation of Numerical Limits

The process of development of numerical limits involves two stages: Risk Assessment and Risk Management.

2.2.1. Risk Assessment

The risk assessment process requires consideration of the results of toxicological and epidemiological studies as well as data on probable human exposure. This process is often divided into various stages that involve an assessment of hazard and an evaluation of risk. There is considerable uncertainty associated with this process for the following reasons:

- **adequacy of the study:** not all toxicological or epidemiological studies reported in the literature are designed or conducted according to accepted scientific standards or protocols.
- **nature of effect:** different types of toxic effects may occur at different exposure concentrations of the same chemical;
- **differences between species:** different species of mammals frequently respond differently to the same concentrations of the same chemical;
- **differences between individuals:** individuals of the same species may show a wide range in sensitivity to the same chemical;
- **interactive effects:** chemicals can interact to enhance or diminish a toxic effect; and

- **adequacy of monitoring and surveillance data:** deficiencies in this data base can lead to wide ranges in population exposure estimates.

The risk assessment process is different for carcinogens and non-carcinogens. All risk assessments must take the various sources of uncertainty into account.

Non-carcinogens are considered to act as threshold agents, that is they exert their effects at or above an exposure threshold. For these chemicals, it is considered appropriate to derive an acceptable-daily-intake (ADI). In general terms, an ADI is calculated by dividing the no-observed-adverse-effect-level reported in a toxicology or epidemiology study by a suitable uncertainty ("safety") factor. The uncertainty factor chosen can range from 10 to 10,000, depending on established criteria.

In the case of carcinogens, the concept of a "threshold" has been debated and has not found wide acceptance. It is now more common to estimate the level of risk than it is to estimate the ADI for a carcinogen. Estimation of risk involves development of suitable dose-response data in a lifetime exposure (carcinogenicity) bioassay of animals and extrapolation from the observed dose-response to low-dose exposures in humans. A number of mathematical models may be used to estimate the dose that is expected to be associated with a specific level of risk (probability) of an adverse health outcome.

Despite the uncertainty in the risk assessment process, there is usually good agreement on ADI values for non-carcinogens. For carcinogens, agreement on unit risk estimates will only be realized if similar risk estimation procedures and models are used.

Once unit risk estimates or ADIs have been set, based on animal or epidemiology studies, an overall evaluation of the risk to existing populations in the area under study can be carried out. This evaluation requires knowledge of the size of the exposed population and the concentration of the contaminant(s) in the various media to which the population is exposed. This evaluation can lead to estimates of morbidity or mortality in the exposed population under consideration and enables jurisdictions to decide whether regulatory action is required.

2.2.2. Risk Management

The second part of the evaluation process leading to a numerical limit involves risk management. Development of a numerical limit by a jurisdiction takes into account the ADI or unit risk estimate calculated for the chemical under review and several other factors such as:

- estimates of intake of the contaminant via all routes of exposure (air, water, food and consumer products) and the percentage of the total daily intake that comes from the exposure route under consideration;
- local differences in exposures (variations in consumption patterns, specific sites with high level contamination, etc.);
- existence of special populations at risk;

- the level at which analytical methodologies can detect, measure and confirm the presence of the contaminant;

- the costs and benefits of restricting or banning a manufactured chemical used in commerce; and

- constraints prescribed or implied in law regarding the intent, development and use of numerical limits.

Many of these conditions vary between jurisdictions, resulting in different risk-management decisions and hence, different numerical limits. Given the wide-range of risk management considerations, it is indeed remarkable that there is as good agreement between the jurisdictions on numerical limits as now exists.

2.3 Conclusion

The Committee submits that there is a need to provide details concerning the bases for the formulation of numerical limits pertinent to the Great Lakes basin. A first step in this process has been the identification of current jurisdictional limits. An IJC Regional Office draft publication prepared for the Water Quality Board (WQB) in 1985 lists existing numerical limits in the basin. In February 1986, the HHEC provided the WQB's Programs Committee with a list of federal and provincial limits on chemical contamination of water and fish for the Critical Pollutants in the primary track. The Coordinating Committee for the Assessment of Chemicals in the Great Lakes Ecosystem is including in its 1987 Report to the Boards a more extensive list of existing limits for the Critical Pollutants. In addition to these outputs, the United States Environmental Protection Agency (U.S. EPA 1984) and Ontario Ministry of the Environment have reviewed the bases for some of the environmental limits that pertain to contaminants in the basin. The Committee welcomes and urges support by the IJC for any initiative by the jurisdictions to meet and confer on methodologies and assumptions for developing numerical standards, guidelines and advisories in water and fish containing environmental contaminants. Emphasis should be placed particularly on improving the consistency of regulatory action as it affects the public.

2.4 Recommendation

The Committee recommends that:

- *a contract to study the basis for establishment of numerical limits for Great Lakes contaminants be undertaken in 1987/88.*

3.0 1983 INVENTORY OF GREAT LAKES CHEMICALS: HEALTH HAZARD EVALUATION

3.1 Background

In its 1985 Report, the Committee discussed its work on the preparation of over 100 new toxicity profiles of chemicals found in fish or water (as identified in the 1983 Inventory of Great Lakes Chemicals developed by staff of the International Joint Commission). The Committee's Report emphasized the importance of updating these profiles, developing additional profiles for chemicals found in sediment and obtaining up-to-date information on the abundance and use of these chemicals in the Great Lakes basin. The addition of the latter data elements would enable the Committee to publish statements concerning the potential hazard (toxicity and exposure) of the compounds to human populations living in the basin and consuming fish and/or water from the Great Lakes. These hazard assessments were part of the overall evaluation process underway through the Coordinating Committee for the Assessment of Chemicals in the Great Lakes Ecosystem.

3.2 Toxicity Profiles

The Committee reviewed the toxicity profiles prepared for the Committee by Canada's Health and Welfare. It also identified an additional 30 chemicals for which there were sufficient toxicological data now available for the preparation of toxicity profiles. Health and Welfare Canada has completed the preparation of draft toxicity profiles on the additional 30 chemicals and has revised and updated all other profiles following a literature search strategy current to December 1986.

3.3 Chemical Exposure Information

In preparation for an evaluation of the approximately 130 chemicals for which toxicity profiles have been developed, the Committee analyzed the information in the 1983 Inventory for indications of the distribution and concentrations in fish and water to determine the potential for human exposure to each contaminant.

The information in the 1983 Inventory is of higher quality than that of its predecessor (Appendix E of the 1978 Water Quality Board Report). The careful screening by the Coordinating Committee for the Assessment of Chemicals in the Great Lakes Ecosystem has eliminated chemicals which are poorly identified, misnamed, or irrelevant for the purpose of this project. Nevertheless, additional reference to the source documents was often needed to determine whether the identifications were made as part of a systematic search for the chemical around a suspected discharge and if so, whether they included measurements of presumably contamination-free zones (background measurements) or whether measurements were made without concern for local or regional conditions and for some other purpose.

The abundance and use data available to the Committee are typically five to ten years old. In general, pesticides were found in the agricultural basins of Lakes Erie and Huron, a large number of chlorinated organics in the Niagara River and

organotins in marinas and harbours. Other identifications were sporadic and primarily the result of:

- a demonstration of a new analytical technique;
- a local public and political concern;
- a request for analysis of a large number of chemicals by a conscientious regulatory official charged with the evaluation of a single wastewater discharge; or
- accidents such as major spills.

There appears to have been little effort by the jurisdictions to undertake more comprehensive monitoring of chemicals of potential concern as identified by the Committee. This situation should be considered carefully by the International Joint Commission (IJC).

Exposure statements based on all data available to the Committee have been prepared and are now under review. The assessment of human exposures and the toxicity of the chemicals under review will lead to the publication of statements by the Committee of the potential hazard posed by these chemicals to residents in the Great Lakes basin. The accuracy of these assessments hinges on the quality of the available data.

3.4 Recommendations

The Committee recommends that:

- *The IJC and Great Lakes jurisdictions should attempt to shorten the cycle of planning, monitoring and reporting to allow a more timely and effective evaluation of the significance of contamination of the Great Lakes ecosystem.*
- *the jurisdictions place emphasis on providing comprehensive data on those chemicals that the Committee has repeatedly identified as of potential health concern.*

4.0 ORGANO–METALLIC CONTAMINANTS IN THE GREAT LAKES

4.1 Alkylated Lead Compounds

Alkylated lead compounds have been used extensively as additives to gasolines and have been manufactured in the Great Lakes basin.

The Committee reviewed the toxicology database for alkylated lead and provided recommendations in its 1985 report for maximum concentrations of total lead in edible portions of fish. In response to the Committee's request for additional data, the Canadian Department of National Health and Welfare completed research studies on triethyl, tetraethyl and inorganic lead. The findings support the concern expressed by the Committee over the toxicity of the alkylated forms of lead. While the use of lead compounds is decreasing, the issue of point–source alkylated lead release requires vigilant attention.

4.2 Organotin Compounds

Organotins are used as industrial stablilizers in the plastics industry and serve as antifouling additives in paints for boat and ship hulls. Environment Canada and the National Research Council of Canada have published extensive reviews of the chemistry and aquatic toxicology of the alkylated tin species. Other studies have indicated that tributyl tin is toxic to many aquatic organisms in the parts per trillion (ppt) range. Methyltin has been found in Kingston and Whitby Harbours and dimethyltin found in sections of Lake St. Clair. The organotins are of concern to the Committee because of their immunotoxic effects on mammals.

4.3 Recommendations

4.3.1 Alkylated Lead Compounds

The Committee reconfirms its 1985 recommendations that:

- *the jurisdictions should continue to monitor organic and inorganic lead concentrations in the edible portions (suitably defined) of fish near point–source discharges so that potential human exposure can be assessed more reliably; and*

- *the discharges from the identified primary sources should be discontinued.*

4.3.2 Organotin Compounds

The Committee recommends that:

- *the jurisdictions gather information on the concentrations, sources and distribution of organotins and consider their toxicological significance.*

5.0 FISH TUMORS

5.1 Background

In its 1985 Report, the Committee stated its interest in studies of fish tumors in the Great Lakes and the potential for the increased incidence of fish tumors to be used as an additional indicator of chemical contamination. Further evaluation of the usefulness of this surveillance system can take place as additional data are obtained. For example, it is necessary to differentiate tumors caused by viruses from those likely caused by chemical carcinogens. In addition, it is imperative to ensure quality assurance and consistency among investigators in the interpretation of fish pathology data. It must also be possible to establish a correlation between the incidence of a tumor and contamination of the species' habitat, before wider-reaching conclusions can be drawn on the indicator value of this surveillance system.

5.2 Conclusion

The Committee believes the jurisdictions should continue to investigate the incidence, pathology and etiology of tumors in Great Lakes fish and the potential of the underlying causes of these tumors to impact upon human health.

5.3 Recommendations

The Committee reiterates its 1985 recommendations that:

- *the distribution and diagnosis of fish tumors in the Great Lakes basin need more extensive documentation and study;*
- *the dose-and-effect relationships for environmental carcinogens in fish need to be determined relative to established animal models, particularly the rat; and*
- *subsequently, the potential for using fish in monitoring for waterborne carcinogens needs to be explored through appropriate scientific research.*

6.0 EMERGING ISSUES IN HEALTH RISK ASSESSMENT

6.1 Background

There have been numerous recent developments in toxicology which will probably affect the way scientists and/or regulatory agencies deal with fundamental issues in toxicology in the near future. The Human Health Effects Committee believes that these developments will influence interpretation of health effects data. The Committee is therefore proposing that scientists who are at the forefront of relevant emerging areas of toxicological evaluation be invited to submit briefing papers on these topics. Proposed topics fall under four general headings:

- Biochemical indicators of contaminant exposure;
- Evaluations of short-term test data;
- Application of the multimedia (total-exposure) approach to the development of regulations; and
- Evaluations of complex mixtures.

The following provides a brief background on these topics and indicates their potential place as tools in the science of toxicology.

6.2 Biochemical Indicators of Contaminant Exposure

One fundamental problem in toxicology involves the assessment of "true dose," i.e. the dose of a given chemical at the target site. In most studies animals are exposed to a chemical or mixture of chemicals orally, dermally or by inhalation and the toxic manifestations are subsequently recorded. Seldom is exposure correlated with target tissue concentration. It would be of great value if biological indices could be determined which would serve as indicators of exposure. The indicators could be used as "warning systems" of exposure in human populations. Specific areas which have been proposed as possible markers include: adducts of nucleic acids and proteins as dosimeters of environmental exposure; enzyme induction; the utilization of monoclonal antibodies for the identification of specific toxic agents; and the potential use of the immune system as an indicator of exposure. The biochemical indicators might respond to both parent compounds and their metabolites. The Committee proposes that experts in this field be invited to submit overview papers covering this general topic and its applicability to the evaluation of the significance of human exposure to such compounds.

6.3 Evaluations of Short-Term Test Data

Over the last decade, a multitude of *in-vitro* test procedures has been developed for the evaluation of the toxicity of both single chemicals and complex

mixtures. The advisability of using such data for purposes of risk assessment (with the assumption that these data have a direct relationship to the carcinogenic potential of the chemicals tested) has generated much debate and concern in the scientific community. Many individuals have defended the use of *in-vitro* testing as a means of arriving at some form of safety evaluation and they have pointed to a number of chemical classes where such testing has been demonstrated to be clearly predictive of the *in-vivo* studies which have been done. Others have stated that the use of *in-vitro* systems for safety evaluations is a gross oversimplification and can lead to erroneous and/or non-relevant conclusions. Certainly the differences in required information and difficulty between qualitative and quantitative risk assessments, especially with *in-vitro* systems, presents one of the key challenges to toxicologists working in risk evaluation. The Committee believes that the methodologies used to evaluate and interpret the results of *in-vitro* testing should be described and their potential rôle in risk assessment defined.

6.4 Application of the Multimedia Approach to the Development of Standards/Regulations

In recent decades, the human population has been exposed to an increasing number of chemicals, such as pesticides, pharmaceuticals and those used in and produced by industrial processes. Many of these chemicals are "persistent", can be found in all environmental media (water, air, soil, food) and may have the potential to produce adverse health effects in humans. Toxicologists have long been aware that the human population is not exposed to most chemicals through a single route but by dietary (food and water), respiratory and dermal routes, each of which may contribute to an observed health effect.

As the potential health effects are recognized, environmental standards (levels of these chemical contaminants felt to be without significant risk) are developed, to protect human health. Exceedance of these standards results in the initiation of control measures. Primarily as a result of traditional organizational structure in government which leads to separate legislative channels, such standards have tended to be developed on a medium-by-medium basis. This approach does not always recognize the existence of multiple routes of exposure--for instance, a standard developed for air exposure may not make allowance for exposure to the same substance from drinking water, food or consumer products.

A multimedia approach to standard-setting would ensure the development of environmental standards for public health protection such that an acceptable level of exposure from all sources is not exceeded. The difficulties inherent in this approach, as well as the ramifications of its use in a regulatory environment are topics which the Committee feels are of direct interest to the IJC. The Committee is therefore recommending that an invited paper be prepared which will serve as an overview of this subject.

6.5 Evaluation of Complex Mixtures

Environmental realities indicate that the human population is seldom exposed to single chemical compounds but rather to complex and often-changing mixtures of chemicals. The number of chemicals which has been clearly identified in the Great Lakes waters is in the hundreds and even if only a small portion of them

reach drinking water supplies or fish, it means that the human population in this area may be exposed to a wide variety of chemicals at any given time. Overall exposure and evaluation of its significance becomes even more complex when these environmental chemicals are added to those that the human population is exposed to at home and in the workplace. The Committee presented an overview of the problems associated with prediction of the effects of mixtures of toxic chemicals in its 1979 Report.

There have been considerable efforts in recent years devoted to:

- determining the potential for chemical interactions to alter the toxic outcome of exposure to complex mixtures;
- approaches for the evaluation of complex mixtures in terms of their overall systemic, developmental and/or carcinogenic effects;
- the development of reliable testing strategies which will enable scientists to carry out better risk assessments;
- the development of mathematical models such as the dose addition, response addition and interactional models which attempt to address the problems of complex mixtures in risk assessment; and
- better chemical characterization of complex mixtures.

In view of recurring questions from the public, the Committee considers current developments in the assessment of the potential effects of complex mixtures on human health in need of review.

6.6 Recommendation

The Committee recommends that:

- *the Boards provide funding for contracts for invited papers which address the following topics:*
  - *biochemical indicators of contaminant exposure;*
  - *evaluations of short-term test data;*
  - *application of the multimedia (total exposure) approach to the development of regulations; and*
  - *evaluation of complex mixtures.*

7.0 RECOMMENDATIONS

7.1 Epidemiological Evaluation of Human Health Effects of Chemicals in the Great Lakes

The Committee recommends that:

- *a workshop be held to debate the choice of epidemiological strategies for investigating environmental health impacts and that the proceedings be published in order to provide guidance to agencies responsible for human health evaluation.*

7.2 Numerical Limits for Great Lakes Contaminants: The Basis for and Variations in Jurisdictional Limits Used in the Great Lakes Basin

The Committee recommends that:

- *a contract to study the basis for establishment of numerical limits for Great Lakes contaminants be undertaken in 1987/88.*

7.3 1983 Inventory of Great Lakes Chemicals: Health Hazard Evaluation

The Committee recommends that:

- *the IJC and Great Lakes jurisdictions should attempt to shorten the cycle of planning, monitoring and reporting to allow a more timely and effective evaluation of the significance of contamination of the Great Lakes ecosystem; and*

- *the jurisdictions place emphasis on providing comprehensive data on those chemicals that the Committee has repeatedly identified as of potential health concern.*

7.4 Organo–Metallic Contaminants in the Great Lakes

The Committee reconfirms its 1985 recommendations that:

- *the jurisdictions should continue to monitor organic and inorganic lead concentrations in the edible portions (suitably defined) of fish near point–source discharges so that potential human exposure can be assessed more reliably; and*

- *the discharges from the identified primary sources should be discontinued.*

The Committee also recommends that:

- *the jurisdictions gather information on the concentrations, sources and distribution of organotins and consider their toxicological significance.*

7.5 Fish Tumors

The Committee reiterates its 1985 recommendations that:

- *the distribution and diagnosis of fish tumors in the Great Lakes basin need more extensive documentation and study;*
- *the dose–and–effect relationships for environmental carcinogens in fish need to be determined relative to established animal models, particularly the rat; and*
- *subsequently, the potential for using fish in monitoring for waterborne carcinogens needs to be explored through appropriate scientific research.*

7.6 Emerging Issues in Health Risk Assessment

The Committee recommends that:

- *the Boards provide funding for contracts for invited papers which address the following topics:*
  - *biochemical indicators of contaminant exposure;*
  - *evaluations of short–term test data;*
  - *application of the multimedia (total exposure) approach to the development of regulations; and*
  - *evaluation of complex mixtures.*

APPENDICES

A. Membership List: Joint Science Advisory Board/Water Quality Board Committee on the Assessment of Human Health Effects of Great Lakes Water Quality

B. Terms of Reference of the Joint Science Advisory Board/Water Quality Board Committee on the Assessment of Human Health Effects of Great Lakes Water Quality

MEMBERSHIP LIST

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TERMS OF REFERENCE

of the

JOINT SCIENCE ADVISORY BOARD/WATER QUALITY BOARD COMMITTEE ON THE ASSESSMENT OF HUMAN HEALTH EFFECTS OF GREAT LAKES WATER QUALITY

The Committee will take the following under its purview:

1. assess the risk to health posed by contaminants in the Great Lakes ecosystem;

2. review action levels and guidelines for selected substances;

3. provide to the International Joint Commission through its boards, interpretation and consultation on health matters; and

4. maintain awareness of current advances and knowledge as they relate to human health aspects of the ecosystem.

Presented to the Science Advisory Board at their 28th meeting, October 25–27, 1978

Presented to the Water Quality Board at their 35th meeting, November 2–3, 1978